Ludus Mathematicus:

OR, THE

MATHEMATICAL GAME:

Explaining the deſcription, conſtruction,, and uſe of the Numericall Table of Proportion.

By help whereof, and of certain Cheſſmen (fitted for that purpoſe) any Propoſition Arithmetical or Geometrical (without any Calculation at all, or uſe of Pen) may be readily and with delight reſolved, when the term required exceeds not 100000.

£. 26.6~~2~~

By *E. W.*

Omne tulit punctum, qui miſcuit utile dulci.

LONDON,
Printed by *R.&W.Leybourn*, and are to be ſold by *Philemon Stephens* at the Gilded Lion in *Paul's* Church yard, *MDCLIV*.

1949:17

THE PREFACE.

THis *Instrument* I at first intended for my own private use & delight, not conceiving it worthy to see the light: but being since informed by others, (well verst in the Mathematicks) and

 finding

finding alſo by experience, that it may prove uſefull for others (and, *Bonum quò communas eò melius*) I have permitted it to launch into the Ocean of cenſure: Howbeit, I preſent it chiefly to ſuch as (in ſome competent manner) have already acquainetd themſelves with the *modern* uſe of Arithmetick, I mean, by *Logarithms, Decimals*, and *Scales*; for, they may be able immediately to apprehend the uſe thereof, and that with ſome pleaſute and delight. To other Arithmeticians not acquainted with that kinde of *Artificiall* Arithmetick, it may (at firſt) ſeeme ſome-

what

what more difficult. But unto ſuch as are not at all verſt in Arithmetick, I may object *Plato*'s Inſcription placed over the doore of his Academie concerning Geometry (including alſo Arithmetick) *Nemo Geometriæ ignarus huc ingreditor.* It profeſſeth to render you the term required in any queſtion propounded, when it will not amount to above 100000, that is, when it exceeds not five figures or places, and that it will cleerly do, (eſpecially towards the beginning of the Scale) when the term or terms out of which the *Queſtion* is to be produced, are *rationall* num-

numbers, *viz.* when the term required to be extracted from them, will be (precisely) a whole number, without a fraction attending it; but when the term or terms given are *irrational* numbers, which will produce a mixt number, consisting of a whole part together with a fraction, in that case it will represent unto you only the whole part thereof, without the broken part or fraction; which defect (neverthelesse) will occasion no inconvenience in the practise of this *Instrument*, the broken part of a number of such an extent being not considerable in Questions of ordinary

practise,

practiſe, as is well known to all *Artiſts* : This advertiſement I have thought fit to premiſe, leſt it might ſeeme to promiſe more than it can perform , and ſo cauſe the *Practitioner* to be fruſtrated of his expectation.

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THE MATHEMATICAL Game.

CHAP. I.

The Definition, Description, and Construction, of the Numericall Table of Proportion.

1\. A *Table of Proportion is an Instrument framed by Logarithms, and invented for the more easie resolving of Arithmeticall and Geometricall Operations.*

In *Naturall* or Vulgar Arithmetick, the Propositions are resolved by using the Numbers themselves, as if 4 were given to be multiplyed by 2, we say, two times four makes 8, the Product. In *Artificiall* Arithmetick, if the same Question were propounded, insteed of 4 and 2, we take their Logarithms; so if the Logarithm of 4 (being 0,602060) be added to the Logarithm of 2 (being 0,301030) their summe is 0,903090 which being found in the Table of Logarithms, is the Logarithm of 8, the Product, as before. Howbeit here, in the use of this Instrument we need not Multiply or Divide, Adde ar Substract, which for the most part perplex and discourage the Practitioner, but by the motion of certain Chesse-men (fitted for that purpose) we perform with pleasure and delight, the hardest Propositions of Arithmetick and Geometry without charging the minde or memory with any thing, which may seeme burthensome or distastfull.

II. *This Instrument is twofold, Numericall or Trigonometricall.*

III. *The*

III. *The Numericall Table of Proportion is an Instrument, by help whereof, aud of certain moveable Chesse-men, all Questions Arithmeticall and Geometricall (performed by* Multiplication, Division, *or the* Golden Rule, *and not Trigonometricall) together with mean Proportionals, & the Extraction of the Roots of all Square-numbers under* 11 *places, and of all Cube-numbers under* 16 *places, as well in mixt and broken, as in whole numbers (when the term required exceeds not* 100000) *are with great ease and exactnesse Resolved.* For we ntend not here to meddle with any uestions, that are performed by the Doctrine of Triangles, referring them o be handled in the use of the Table f Proportion Trigonometricall.

IV. *Of the Numericall Table of Proportion these things offer themselves to e considered,* viz. *The Description and onstruction, or the Use.*

V. *For the more plain describing of is Instrument, it may be said to consist two parts,* viz. *The Body of the Table it self and substantiall part, or the*

Appendants and Circumstantiall part thereof.

VI. *The Bodie of the Table it self is a Scale of unequall parts broken off into Fractions, and hereafter (for distinction sake) called the Scale of Numbers.* This Scale is nothing else but a line of Numbers broken off into 36 fractions or equal parts; Now what a line of Numbers is, hath been heretofore taught by Mr. *Gunter* in his Book of the *Crosse-staffe*, and is well enough known to all modern Artists.

VII. *A Fraction of the Scale of Numbers is an equall part of the same Scale, consisting of Lines, Spaces, and Divisions:* So this Scale is broken of or divided into thirty six of those equal parts or fractions, numbred at their right ends by 1, 2, 3, &c. to 36, of which the part signed at the left end thereo by 100 is the first Fraction, that signe by 107, is the second, &c.

VIII. *Each of these Fractions consists of three lines and two spaces:* fo the pricked line which you finde place under each Fraction, is not to be take

as any part thereof, but hath another uſe, as ſhall be declared in the proper place.

IX. *Theſe Fractions, together with their Lines and Spaces muſt be underſtood to joyn reſpectively one to another, in ſuch ſort that the whole Scale of Numbers may be conceived to be one entire and continued Line:* For *Example.* The right end of the firſt Fraction marked by 1 *A.* muſt be conceived to joyn with the left end of the ſecond Fraction, ſigned by 107, and the right end of the ſecond Fraction, marked by 2 *B.* muſt be underſtood to joyn with the left end of the third Fraction, noted by 114: And ſo conſequently of the reſt in their order: ſo that the whole Scale of Numbers, beginning at the left end of the firſt Fraction (ſigned by 100) and ending at the right end of the laſt Fraction (noted by 36 *F.*) muſt be conceived to be one intire and continued line, as aforeſaid: And therefore (by farther conſequence) in mounting upwards the left end of the laſt Fraction, ſigned by 939, muſt be alſo conceived to joyne

with the right end of that above it, signed by 35 *E.* and so of the rest, in ascending upwards, untill you mount to the beginning of the Scale.

X. *The intire Scale of Numbers is first divided into a thousand unequall parts, which are hereafter called Hundreds, and distinguished by having three figures placed at the beginning of each of them:* so 100 (at the beginning of the Scale) are the figures of the first Hundred; 101, of the second Hundred; 102, of the third Hundred; 103, of the fourth Hundred, &c.

XI. *Each of these Hundreds are again sub-divided into ten other unequall parts, hereafter called Tenths; and each Tenth also supposed to be again divided into ten other parts, called Units:* For the distances between the Tenths being small, they will not admit any reall division of the same Tenths into ten other parts: And therefore you are to suppose them to be so divided; and hereafter when you shall have occasion to use those parts, you are to guesse at them, as to direct your eye to the middle

dle of them, when you are to take five of theſe Units; and ſomewhat beyond the middle, when ſix of them are propounded, &c. Howbeit, becauſe at the beginning of the Scale of Numbers the diſtance of the Tenths are ſo large, that you cannot readily (in manner aforeſaid) gueſſe at the Units comprehended betwixt them, I have cauſed that diſtance upon the firſt ſix Fractions to be divided into five parts, each part repreſenting two Units; and from thence upon the ſix Fractions next after following into two parts, each part repreſenting five Units; In the mean time, diſtinguiſhing the Tenths comprehended betwixt every two hundreds by ſharp points riſing from the middle line of the Scale into the uppermoſt ſpace thereof, and upon all the reſt of the Scale, leaving the Units to be gueſſed at, as aforeſaid.

XII. *To deſcribe the Hundreds and Tenths upon the Scale of Numbers*; *Having firſt prepared a Scale of* 100 *equall parts, containing in length the hundred part of the whole intended Scale of Num-*

bers (which Scale of equall parts must be supposed to be divided into 1000 *equall parts, the distance betwixt each hundred part thereof being supposed to be divided into ten parts) repair to the Table of Logarithmes, and therein observing the first five figures of the Logarithme of* 1001, *besides the Characteristique or Index* (viz. 00043) *take with your compasses the distance from the beginning of your Scale of equall parts to the said* 43; *this done, if you applie that extent of the compasses towards the right hand from the beginning of your intended Scale of Numbers, the moveable point of the compasses will fall upon the first tenth of that Scale: In like manner, by the first five figures of the Logarithme of* 1002, *besides the Index* (viz. 00086) *you may mark out the second tenth of the same Scale, and so consequently all the rest in their due order.*

Example, If it were propounded to make a Scale of Numbers equall to this whereof we treat; this Scale being intirely taken together, as one continued Scale, according to the ninth

ninth Rule aforegoing) it conteins in length 75 feet, which amount to 900 Inches, whereof the hundred part is nine Inches; wherefore, having prepared a Scale nine Inches long, as is above directed, I take off with my compasses the parts 43, which extent being applied from the beginning of the Scale of Numbers towards the right hand, the moveable point will fall upon the first tenth of the first hundred of that Scale, just under the letter Z; so likewise if I again take off upon the Scale of equall parts the figures 86, and apply them from the beginning of the Scale of Numbers, as before; that extent will mark out the second tenth of the same Hundred just under the letter *X*. In like manner also may you proceed, untill you have described all the divisions of the Scale of Numbers, as you see here drawn upon this Instrument.

This may suffice to have spoken of the substantiall part, or Body of the Table it selfe; in the next place followes the circumstantiall part, or Ap-

pendants thereof to be handled.

XIII. *The Appendants of the Table are either externall, and placed without it; or internall, and placed within it.*

XIV. *Those placed without it are either so placed at the top above it, or on each side thereof,* viz. *at the ends of the Fractions.*

XV. *The Appendant placed at the top above it is the whole length of the Table divided into 36 equall parts, numbered by 1, 2, 3, &c. to 36, and signed by six Alphabets, each of them consisting of six letters,* viz. *A,* B, C, D, E, *and* F. *And all these Alphabets taken together, are hereafter (for distinction sake) called the Top-rank of Alphabets.*

XVI. *The two ends of this Top-rank ought to be conceived to joyn interchangably to each other, in like manner as if the Alphabets and Letters were placed in a Circle.*

For *Example*; If B in the fourth Alphabet were propounded, and I were to account from that letter four Alphabets and three letters towards the right hand: The letter *A* in the fift Alphabet

bet makes one Alphabet, and *A* in the ſixt Alphabet is the ſecond Alphabet; but now becauſe in proceeding to account another Alphabet, I ſhall go beyond the right end of the line; for the third Alphabet I take *A* in the firſt Alphabet; and for the fourth I take *A* in the ſecond Alphabet; and ſo have I all the four Alphabets demanded: And then I account three letters from the laſt *A* taken, which leads me to the letter *D* in the ſaid ſecond Alphabet, being the letter required. In like manner, if I were to proceed towards the left hand, and *C* in the ſecond Alphabet were the term given, from whence I am to account three Alphabets and five letters; *D* in the firſt Alphabet is the firſt Letter in that account, *D* in the laſt Alphabet is the ſecond, and *D* in the fift Alphabet is the third; from which if I account five letters the ſame way, *viz.* towards the left hand, at laſt I ſhall fall upon *E* in the fourth Alphabet, which is the letter required.

XVII. *The Appendants placed on each ſide of the Table, are ſo placed on the*

the right hand, or on the left.

XVIII. *That placed on the right hand is another like rank of Alphabets, which is hereafter called the side-rank of Alphabets.*

XIX. *The two ends also of this side-rank ought to be conceived to joyne interchangably to each other, as those of the top-rank.*

For *Example*, If *D* in the third Alphabet were propounded, and it be demanded from thence to account downwards five Alphabets and four letters; descending downwards, I finde *C* in the fourth Alphabet to be the first; *C* in the fifth, the second; *C* in the sixth, the third; and then *C* in the first Alphabet is the fourth; and *C* in the second Alphabet is the fifth; from whence if I account four letters, at last I fall upon *A* in the third Alphabet, which is the letter required: so likewise if *E* in the second Alphabet be given, and it be required to account upwards four Alphabets and three letters; first, *F* in the first Alphabet is the first; *F* in the last Alphabet is the second

cond; *F* in the fifth Alphabet is the third; and *F* in the fourth is the fourth; from whence I account three Letters upwards, which guides me to the letter *C*, in the ſaid fourth Alphabet, being the letter deſired.

XX. *The Appendant placed on the left hand is nothing elſe but a rank of Numbers, expreſſing the three figures of the firſt Hundred of every Fraction reſpectively*, and ſerveth for the more readie finding out of numbers upon the Scale, as ſhall be more clearly taught hereafter.

XXI. *The Interval appendants placed within the Table are either Alphabets or Parallels: The Alphabets are nothing elſe but the top-rank of Alphabets ten times repeated in the body of the Table: The Parallels are certain pricked lines, which croſſe one another at right angles, and are either Perpendiculars or Tranſverſals.*

XXII. *The Perpendiculars are pricked lines drawn downwards through the Bodie of the Table from every diviſion of the top-rank of Alphabets.*

XXIV.

XXIII. *The ſpaces comprehended betwixt every two perpendiculars are called Intervals.*

XXIV. *The Tranſverſals are alſo pricked lines drawn under the top-rank, and likewiſe under every Fraction reſpectively, whereof that placed under the top-rank is called the Chief Tranſverſall:* And each of thoſe Tranſverſals placed under the Fractions reſpectively, is termed the Tranſverſall of the Fraction, under which it is ſo placed; and therefore the right end of each of them is to be conceived to joyn with the left of the next under it; as alſo the left end of each of them to joyn with the right end of that next above it: In like manner, as the Fractions are ſaid to do in the ninth Rule aforegoing.

XXV. *The parts of the Tranſverſals comprehended in the Intervals betwixt every two of the Perpendiculars are by points divided into ſix equall parts, called* Digits, *and each of thoſe ſix parts are again ſuppoſed to be ſub-divided into ſix other equall parts, termed* Minimes.

CHAP. II.

Numeration upon the Scale of Numbers.

I. *THus far the deſcription and conſtruction of this Inſtrument; the uſe followes, which conſiſts in Numeration and Application.*

II. *Numeration upon the Table teacheth how to finde out numbers, and diſcover diſtances thereupon; and it is performed either upon the Scale of Numbers, or upon the Alphabets and Tranſverſals.*

III. *Numeration upon the Scale of Numbers is to finde thereupon any number propounded, or any point thereof being aſſigned, to diſcover the figures or number repreſented at that point.*

IV. *If a number conſiſting of five places or more be given, to finde the point upon the Table, where that number is repreſented; proceed thus: Firſt, finde amongſt*

amongſt the numbers placed at the left ends of the Fractions the three firſt figures of the number given, or if you cannot find the three figures exactly, take that nūber amongſt th m, which being leſs, cometh neereſt unto them; this done, upon that Fraction make ſearch for the Hundred, which begins with thoſe three firſt figures of the number propounded, and for the fourth figure count ſo many Tenths of that hundred, & for the fifth figure ſo many units of the tenth laſt teken; all this performed, that place is the point, at which the nūber propounded is repreſented.

Example. let 11422 be the number given to be found upon the Scale of Numbers; here 114, the three firſt figures thereof are found at the left end of the third Fraction, which leads me to the firſt hundred of that Fraction, ſigned by the ſame figures; then for 2, the fourth figure of the number given, I count 2 tenths frō the beginning of that hundred, w^ch brought me to the ſecond tenth of that hundred: & for 2, the laſt figure of the number given, I count 2 units of the tenth laſt taken, which leads

leads me to the point of the Scale of Numbers placed just above the letter q, which point is the place where the number propounded is represented upon the same Scale: so likewise, if the number given did consist of more places than five, it would be represented at the same point, as 11422004500, or 1142212974 are also there represented: But if the number given were 32292, because I cannot finde exactly the three first figures thereof at the left ends of the Fractions, as before, I take 517, which being lesse, comes neerest unto them, and guides me to the 19 Fraction upon which finding the three first figures of the number given at the sixth hundred thereof, I take those three figures to be there represented, and proceeding, as before, I finde the last number given to be represented upon that 19 Fraction at the point placed just above the letter g. Again, if the number propounded were 32205, you shall finde it represented upon the same 19 Fraction just above the letter y, for (in this case) there being a cypher in the place

place of tenths, no tenth is to be taken in the discovery of that or the like number upon the Scale.

V. *If a number consisting of four places, or (over and besides the four places) having a cipher in the fifth place, be propounded, it may be discovered upon the Scale in like manner as the first four figures are found out by the last Rule:* So if 1142, or 114200000 were given, they would be both represented upon the third Fraction at the second tenth of the first hundred, as before; and if 32290000 or 322905321 were given they would be found upon the 19 Fraction at the ninth tenth of the sixt hundred of that Fraction.

VI. *If a number consisting of three places, or (besides the three places) having ciphers in the fourth and fifth places thereof, were propounded, it is represented at the hundred, signed by the same three figures:* So 114, or 11400, or 11400C00 or 114005321 are all represented at the first hundred upon the third Fraction; and 322, or 322000, or 32200273 are found at the sixth hundred of the 19 Fraction.

VII.

VII. *If a number consisting of two places, or (besides the two places) having ciphers in the third, fourth, or fifth places thereof were propounded, it is represented at the hundred, which hath those two figures and a cipher annexed unto them:* So if 13, or 13000, or 130000, or 1300 000, or 13000734 were given, they are all represented at the first hundred of the fifth Fraction.

VIII. *If a number of one figure or place, or (besides that one place) having ciphers in the second, third, fourth, or fift places thereof, were given, it would be represented at the hundred, which is signed by that one figure, and two ciphers annexed unto it:* So if 1, or 10, or 100 or 1000, or 10000, or 100000, or 10000426, &c. were assigned, they would be all represented at the beginning of the Scale, signed by 100: so likewise if 3, or 30, or 300, or 3000, or 30000, or 300000, or 30000342 were propounded, they would be found at the fourth hundred of the 19 Fraction, &c.

IX. *When the number propounded is*

mixt,

mixt, reduce the broken part thereof to a Decimall Fraction, and then finde the whole upon the Scale, as if it were a whole number : So 5 $\frac{3}{4}$ being given, and the broken part thereof (*viz.* $\frac{3}{4}$) reduced to a Decimall, *viz.* 75 ; the intire number given after such reduction will be found 5.75, which is represented at the 13 hundred of the 28 Fraction : In like manner, 12 *l.* 13 *s.* 5 *d.* being propounded, and 13 *s.* 5 *d.* (the broken part thereof) reduced to the Decimall .6708 , that intire number will stand thus, 12.6708, which is represented at the seventh tenth of the fift hundred of the fourth Fraction.

The great use and benefit of reducing ordinary broken numbers to Decimals is now so commonly known to most Artists, that I conceive it not necessary here to insist long thereupon : Only I will here insert certain Tabular Scales, which may serve for the ready reduction of compound Fractions (*viz.* of *Money*, *weight*, *Measure*, and *Time*, which usually incumber the Practitioner)

ner) to *Decimals*.

Upon these Tabular Scales you shall finde the compound Fractions described in the upper Scales thereof, and in the lower their respective Decimals; the first of them (being broken into ten equall parts or Fractions) reduceth the Fractions of *Money* & *Troy-weight*, the Integers thereof being a pound sterling for *Money*, and an ounce *Troy* for *Troy-weight*: The second (broken off into two Fractions onely) reduceth *Avoirdupoiz* Great weight: The third *Avoirdupoiz* Little weight, and all other measures or weights, which divide themselves into halves, quarters, &c. And the fourth is made for the reduction of Time, Dozens, and Inches: so upon the first Tabular Scale the Decimall of 8 *s*. 3 *d*. 3 *q*. is .4156, and the Decimall of nine peny weight and seven grains is .4646. Also upon the second, the Decimall of 3 quarters of *C*. 8 *lb*. and 7 *ounces* is .825. The like reduction may also be made upon the other two Tabular Scales, according to their severall and respective divisions.

How-

Howbeit, if you please yet to have a more compendious way for the reduction of the Fractions of *Money* and *Troy-weight*, you may do it by the first of the double Scales, drawn at the left end of the Table of Proportion, by which pence and farthings (for money) and grains and half grains (for Troy-weight) may be readily reduced; there being no great difficulty in reducing shillings and peny-weights to Decimals, as is well known to all such as are competently acquainted with the nature of Fractions. The other little Scales there also placed (being for Avoirdupoiz weight and Time) give you the Decimall of one quarter, which is to be added to the Decimals of one quarter (*viz.* 25) or of two quarters (*viz.* 50) or of three quarters (*viz.* 75) as the question may be propounded.

X. *When the term propounded is a Fraction or broken number, convert it to a Decimall, and then finde it upon the Scale of Numbers, as if it were a whole number:* So $\frac{1}{4}$ or 25 is found at the sixt hundred of the 15 Fraction, and

85.

8 *s*. 3 *d*. 3 *q*. or 4156 at the ſixth tenth of the ſeventh hundred of the 23 Fraction.

X I. *When a point upon the Scale of Numbers is aſſigned, to finde out the number repreſented by that point, invert the rules aforegoing, & ſo ſhall you diſcover the number or figures you look for.* So if the point *q* were given upon the third Fraction, the number or figures repreſented by it will be found 11422: Alſo if the point g were aſſigned upon the 19 Fraction, the number or figures repreſented by it are 32292, as appears by the two examples of the fourth Rule aforegoing. The like alſo may be ſaid of all the other examples above in this Chapter produced.

CHAP

CHAP. III.

Numeration upon the Alphabets and Transversals.

I. *Numeration upon the Alphabets and Transversals, teacheth how to discover distances betwixt points or termes assigned thereupon.*

II. *Three letters in either rank of Alphabets being propounded, to finde a fourth, which shall bear like distance from the third, that the second bears from the first; proceed thus, Count the intire Alphabets and Letters, which are intercepted betwixt the letters of the first and second termes, then from the letter of the third term account as many intire Alphabets and Letters the same way; that done, the letter placed next beyond the last letter so accounted, is the letter required.*

Example. In the top-rank of Alphabets let *E* in the first Alphabet, A in the third, and *B* in the fourth be given: In

this

this caſe I place three pointed Cheſſe-men in the Chief Tranſverſal, *viz.* one under *E*, another under *A*, and a third under *B*; This done, and I finding one Alphabet and one letter betwixt the two firſt termes *E* and *A*, and accounting the like from *B* in the fourth Alphabet towards the right hand, at laſt I fall upon *D* in the fift Alphabet, which is the letter required, where I alſo place another pointed Cheſſe-man: So if *C* in the third Alphabet, *D* in the fift, and *B* in the ſixt be propounded, *C* in the ſecond Alphabet will be the fourth term you look for, according to the 16 rule of the firſt Chapter. Again, if *F* in the fift Alphabet, *C* in the third, and *D* in the firſt be given: In this caſe, working towards the left hand, the fourth term will be *A* in the fift Alphabet: likewiſe if *B* in the third Alphabet be the firſt term, *D* in the firſt be the ſecond, and *C* in the fourth be the third term, the fourth term will be *E* in the ſecond Alphabet, &c. After the ſame manner, in the ſide-rank of Alphabets three letters being given, a

fourth may be diſcovered by this Rule and the 19 Rule of the firſt Chapter, which being plain, I omit to exemplifie: And in all theſe Caſes and the like, it mattereth not whether you account the Alphabets and letters from the firſt term to the ſecond, or to the third; as in the laſt example, if I account an Alphabet from the firſt term to the third towards the right hand, and then the like from the ſecond term the ſame way, the fourth term will then alſo fall at *E* in the ſecond Alphabet, as before: The like experiment you ſhall alſo find in the ſide-rank, &c. In like manner, if two letters were given, and it be deſired to finde a third, which may bear like diſtance from the ſecond that the ſecond bears from the firſt; In this caſe alſo count as many letters from the ſecond towards the third, as you find intercepted betwixt the firſt and the ſecond, and ſo ſhall you likewiſe have your deſire. For *example*, if *E* in the firſt Alphabet, and *A* in the third were given, the third letter will fall to be *C* in the fourth Alphabet, &c.

The

The like experiment may be alſo acted upon the ſide rank, as may plainly appear without further inſtruction.

III. *when three points are aſſigned upon the Chief tranſverſal, to finde out a fourth, which may bear the like diſtance from the third, that the ſecond beares from the firſt, proceed thus; Having placed (as before) a Cheſſeman at each of the points given, and (by the Rule aforegoing) found the letter under which the fourth term is likely to fall, and there alſo placed another Cheſſeman, as before; draw back that laſt Cheſſeman quite thorow the laſt letter ſo counted, and place it upon the perpendicular, where that laſt letter begins; this done, obſerve how many intire digits are comprehended betwixt the firſt given point, and the next perpendicular towards the ſecond point, as alſo how many ſuch digits are contained betwixt the ſecond given point, and the next perpendicular towards the firſt given point, and to theſe*

adde the intire digits that are found betwixt the third given point, and the next perpendicular towards the same hand, according to which the digits of the second point were taken off. All this performed, if you adde all these three numbers of digits together, and according to that aggregate advance the last Chesseman forward again, and proceed in like manner with the Minimes, as before with the digits, advancing also that Chesseman forward, according to the aggregate of the Minimes, over and above the digits so found, you will at last fall upon the fourth point required.

Example, Admit the first point or term to be given at four digits, and four Minimes of the third letter in the first Alphabet (being *C*) *viz.* at *a*; the second at four digits and four Minimes of the last letter in the second Alphabet (being *F*) *viz.* at *b*; and the third at four digits and four Minimes of the third letter in the fourth Alphabet (being *C*) *viz.* at *c*, and let it be desired to finde a fourth point, which shall bear like distance from *c*, that *b* bears

from

from *a*. Here, by the rule aforegoing, I finde *F* in the fift Alphabet to be the letter where the Chesseman of the term inquired will rest, and therefore (according to this Rule) draw it back and set it upon the 29 perpendicular, *viz*. at the beginning of the last of the intire letters intercepted: This done, I observe one intire digit betwizt the point *a*, and the nezt perpendicular towards *b*, signed by 4, and four digits betwixt *b*, and the next perpendicular towards *a*, signed by 12, these being added together make five, unto which I also adde four for the number of intire digits contained betwixt *c*, and the perpendicular signed by 21, all rhese added together make nine, according to which I advance the Chesman of the fourth point or term (from the perpendicular 29, where I last placed it) to the letter *e*, to the end there may be nine intire digits comprehended betwixt it and the place from whence I tooke it: Lastly, having observed two minimes at *a*, four minimes at *b*, and four likewise at *c*, and added them together, their summe is ten, according

to which I yet again advance the fourth Chesseman ten minimes forward, and so at last the point or term required will be found to reside at the point *d*; so likewise, if *d* were the first term, *c* the second, and *b* the third, the fourth term would fall at *a*; also if *b* were the first, *c* the second, and *d* the third, the fourth term would then also fall at *a*, by going beyond the line, according to the 16 Rule of the first Chapter before-cited. Again, if *c* were the first, *b* the second, and *a* the third, the fourth term would be found at *d*, &c. And here note, that the demonstration of this Rule may be produced from the nature and properties of Arithmeticall proportion, which (for brevitie sake) I leave to the further scrutinie of the Practitioner: In some cases also the first and second termes will fall out to be so neer together, that you may easily discover the like distance betwixt the third and fourth termes upon view, without any farther trouble.

IV. *What hath been here (by the two last*

laſt Rules) practiſed upon the top-rank of Alphabets (with the Tranſverſals, Digits and Minimes thereunto belonging) may be likewiſe performed by the Alphabets repeated through the body of the Table, and their reſpective Tranſverſals, Digits and Minimes placed under the Fractions: And that, albeit the termes or points given are propounded upon ſeverall Tranſverſals; ſo as the Tranſverſall, upon which the fourth term will fall, be alſo aſſigned.

Example. Let the firſt term be given upon the tranſverſal of the fift Fraction at four digits and four minimes of the third Interval, ſigned by *C*, *viz.* at the point *f*, and the ſecond term upon the tranſverſal of the 19 Fraction at four digits and four minimes of the twelfth Interval, ſigned by *F*, *viz.* at the point g. And the third upon the tranſverſal of the 10 Fraction at four digits and four minimes of the 21 Interval, ſigned by *C*, *viz.* at the point *h*, and let the demand be to find a 4th. point upon the tranſverſal of the 24 Fraction, which may bear ſuch like

diſtance from the third point given, as the ſecond beares from the firſt.

Here firſt of all, having placed at each of the terms given a pointed Cheſſman, I finde (as in the firſt example of the laſt Rule) eight Intervals, (or rather one Alphabet and two letters) to be intercepted betwixt the firſt and ſecond termes, and therefore accounting as many (towards the ſame hand) from the third term, I find the fourrh term to be likely to fall upon the Tranſverſal of the ſaid 24 Fraction in the 30 Interval, ſigned by *F*; where having placed another pointed Cheſſeman, I bring it back to the beginning of the laſt accounted letter, and then proceeding with the digits and Minimes of the terms propounded, and advancing that fourth Cheſſeman accordingly (as in the firſt example of the laſt Rule) at laſt I diſcover the fourth term required to fall upon the Tranſverſal of the 24 Fraction at 4 digits and 4 Minimes of the ſaid 30 Interval, *viz.* at the point *k*; ſo likewiſe if *k* were the firſt term, *b* the ſecond, and g the third (working

ing towards the left hand) *f* would be found to be the fourth, &c.

V. *Having three points given upon three ſeverall tranſverſals, to diſcover the tranſverſall upon which the fourth term will fall, and alſo the point of that tranſverſall, where that fourth term will beare like diſtance from the third point, that the ſecond beares from the firſt: Obſerve this direction, having placed (as before) three Cheſſemen at the three given points, place likewiſe three other plain Cheſſemen upon the ſide rank of Alphabets, at the right ends of the fractions or Tranſverſals, whereupon the points given are ſcituate reſpectively: This done (by the ſecond Rule of this Chapter) find upon the ſaid ſide-rank a fourth term to the three given, which will lead you to the Tranſverſal upon which the fourth term required is to be found; then proceeding, according to the directions of the laſt Rule, you will diſcover the fourth point or term you look for.*

Example. If *f*, *g*, and *h*, (the points of the firſt example of the laſt Rule) be given, *viz.* upon the 5, 19, and 10

Fractions, as before; In this Case, I place a plain Chesseman at the right end of the fift Fraction, another at the same end of the tenth Fraction, and a third at the like end of the nineteenth Fraction, and (in working downwards) discover upon that side-rank of Alphabets (by the second Rule of this Chapter) a fourth term correspondent to the other three given terms, which fourth term leads me to the 24 Fraction and transversal, upon which the fourth term in question is scituate. And therefore proceeding thereupon, as in the first example of the last Rule, you will find the fourth term required (in this example) to fall upon the transversal of that 24 Fraction, at four digits and four minimes of the 30 Interval, *viz.* at the point *k*, as before. In like manner, if *k* were the first term, *h* the second, and *g* the third, (in mounting upwards upon the side rank, and proceeding upon the Table towards the left hand, as I did before towards the right) the fourth term will (in that case) be found to fall upon the transversal

verſal of the fift Fraction at four digits and four minimes of the third Interval ſigned by *c*, *viz.* at the point *f*. So if *g* be the firſt term, *h* the ſecond, and *k* the third (the Fraction or tranſverſal of the fourth term being found upon the ſide rank, and I guiding my work upon the Table towards the right hand) the fourth term will fall upon the tranſverſal of the 15 Fraction at 4 digits and 4 minimes of the 3 Interval, ſigned by *c*, *viz.* at the point *l*, Howbeit you are not to take that for the true point, but (becauſe in that caſe you go beyond the Table towards the right hand, and for that the right end of the 15 Fraction is conceived to joyn with the left end of the 16 Fraction, according to the directions of the 9, 16, and 25 Rules of the firſt Chapter) you are to take 4 digits and 4 minimes of the tranſverſal next under it in the ſame Interval, and ſo the true point required will be (in that caſe) found to reſide upon the tranſverſal of the 16 Fraction at 4 digits and 4 minimes of the ſaid third Interval, *viz.* at the point *m*. In like manner, if the three termes

propounded, were *h*, g, and *f*, and a fourth term be required anſwerable unto them: In that caſe (the proper Fraction or Tranſverſal of that 4th term being diſcovered upon the ſide rank, & I proceeding towards the left hand) the 4th term will fall upon the Tranſverſal of the 14 Fraction at 4 digits and 4 Minimes, of the 30 Interval, *viz.* at the point *n.* Howbeit (as in the laſt aforegoing example) you are not to take that for the true point; but in that caſe (becauſe you go beyond the Table towards the left hand, and for that the left end of the 14 Fraction is conceived to joyn with the right end of the 13 Fraction, according to the ſaid 9, 16, and 25 Rules of the firſt Chapter) you are (inſtead thereof) to take 4 digits and 4 Minimes of the tranſverſal next above it in the ſame interval, and ſo true point required will be found to reſt upon the tranſverſal of the 13 Fraction at 4 digits and 4 minimes of the ſaid 30 Interval, *viz.* at the point *p.* And here, give me leave (once for all) to inſert this direction, that in the motion of

of a Chesſeman upon the Table, when you are conſtrained to over-ſhoot the table either on the right or left hand, take the Fraction next to it, either above or below it, *viz.* if on the right hand, then the Fraction below it, but if on the left hand, then that above it, as in the two laſt premiſed examples you finde it practiſed.

Again, if *f* be the firſt term, *g* the ſecond, and *k* the third, the fourth term will fall upon the third Fraction at 4 digits and 4 minimes of the third Interval, *viz.* at the point *q*; and in that caſe you do not onely fall off at the lower end of the ſide-rank, taking it again at the top, but likewiſe overſhoot the table upon the right hand, and take it again upon the left, and (in that reſpect) take not the fraction whereunto you are directed by the fourth term found in the ſide-rank, but take the next under it: On the other ſide, if *k* were the firſt term, *h* the ſecond, and *f* the third, the fourth term will reſide upon the 27 Fraction at 4 digits and 4 minimes of the 30 Interval, *viz.* at the point

point *r*. And (in that caſe alſo) you do not onely mount off at the top of the ſide rank, taking it again at the lower end, but likewiſe over-ſhoot the Table upon the left hand, and take it again upon the right, and (in that regard alſo) take not the Fraction, unto which you are directed by the fourth term found in the ſide rank, but take the next above it, according to the direction of the afore-going examples.

VI. *After the ſame manner may you alſo diſcover a third term to two termes propounded, ſave onely, that (in regard the ſecond term doth in a ſort in that caſe repreſent the two middle termes) you are to double the digits and minimes of the ſecond term, and then adde them to the digits and minimes of the firſt term, to the end, you may underſtand by that ſumme how far to advance the Cheſſeman of the laſt term.*

For *example*. Let *f* be the firſt term, and g the ſecond, and let a third term be deſired, here (Cheſſemen being placed

ced at the terms given, and likewiſe upon the ſide rank at the ends of the Fractions, upon which they are reſpectively ſcituate) I find the third term to fall upon the 33 Fraction; and then obſerving eight Letters or Intervals to be intercepted betwixt the firſt and ſecond termes, accounting as many from the ſecond towards the third, I find the Cheſſeman of the third term to be likely to fall upon the ſaid thirty third Fraction in the one and twentieth Interval, ſigned by *c*, and therefore draw that Cheſſeman back to the twenty perpendicular upon the ſame thirty third Fraction: this done, and I obſerving one digit at the firſt term, and four at the ſecond, I double thoſe four, and adde them to the one, all which amounting to nine, I advance the Cheſſeman of the laſt term accordingly, ſetting it in the middle of the one and twentieth Interval; then finding alſo at the firſt term two minimes, and four at the ſecond, I likewiſe double the four,

four, and adde them to the 2, all which amount to 10, according to which ſumme I advance the Cheſſeman of the third term ten minimes farther, and ſo at laſt I finde the ſaid third term to fix upon the 33 Fraction at four digits and four minimes of the 21 Interval, which is the term required. And if at any time in working queſtions of this kinde you happen to deſcend below, or aſcend above the ſide-rank, or otherwiſe overſhoot the table either on the right hand, or left, you are (in ſuch caſes) to uſe the Rules aforegoing, but ſtill doubling the digits and minimes of the ſecond term, as in the premiſed example. In like manner may you alſo (if you pleaſe) diſcover a fourth term to thoſe three known, and ſo (conſequently) a fift, ſixt, ſeventh, &c. *in infinitum.*

VII. *A point upon any one of the tranſverſals being given, to find halfe the diſtance betwixt that point, and the beginning or left end of that tranſverſal; follow this direction: Take half the Alpha-*

Alphabets, half the letters, half the digits, and half the minimes intercepted betwixt the beginning of that line and the point given, and ſo ſhall you have your deſire. So if the point *c* upon the chief tranſverſal were propounded, half the diſtance betwixt the beginning or left end thereof, and that point will be found at two digits and two minimes, of the letter *E* in the ſecond Alphabet, *viz.* at the point *S*, for, in this caſe, there being three Alphabets and two letters intercepted betwixt the beginning of that traverſal, and the letter wherein the point given is ſcituate, I take one Alphabet and three letters for the three Alphabets, and one letter more for the two odde letters; then for the four digits I take two digits, and for the four minimes, two minimes; all which being accounted from the beginning of that tranſverſal will fall at *S*, the point required: the ſame may likewiſe be acted upon any of the repeated Alphabets and tranſverſals in the body of the table.

VIII. *Upon any one of the Tranſverſals*

verſals, to diſcover the third part of the diſtance betwixt the beginning or left end thereof, and any point thereupon propounded: this is the Rule; Take the third part of the diſtance in Alphabets, letters, digits, and minimes, and ſo ſhall you attain the point or term required. So the point *c* upon the chief tranſverſal being again propounded, the point *t* will be third part of the diſtance inquired. For in liew of the three Alphabets I take one; for the third part of the two odde letters, I take four digits; for the four other digits I take one digit and two minimes. And for the four laſt minines I take one minime and ſomewhat more, by which meanes *t* will be found at laſt the point ſought for: Thus likewiſe you may be practiſed upon the repeated Alphabets and tranſverſals.

IX. *A Fraction of the Scale of Numbers being given, to finde upon the ſide rank of Alphabets the half diſtance betwixt it, and the firſt Fraction (including the firſt Fraction for one) proceed in this mannner; firſt, having placed*

ced a plain Cheſſeman (without a point) at the right end of the Fraction given, obſerve whether the number of the Fraction next above it be even or odde; if even, then take half the ſumme thereof, and place another plain Cheſſeman at the right end of the Fraction next under that half ſumme: but if the number be odde, neglecting the odde Fraction, proceed with the even number, as before, nnd ſo you ſhall accompliſh your deſire.

Example. Let the Fraction ſigned at the right end thereof by 21 be given, and let the half diſtance betwixt it and the firſt Fraction be demanded. Here, the number above it is 20, whereof the half is 10; wherefore I taking a Cheſſeman, place it at the right end of the Fraction, ſigned by 11, which is the half diſtance demanded. And if the 22 Fraction were propounded, the half diſtance would ſtill remain the ſame: Howbeit (in that caſe) the odde Fraction ſigned by 21, would remain over and beſides the two moities, which

which neverthelesse will produce no errour in the use of the table, as shall appear hereafter.

X. *A Fraction of the Scale of Numbers being propounded, to discover upon the side-rank of Alphabets the third part of the distance betwixt it and the first Fraction (including the first Fraction for one) use this Rule; Having placed a Chesseman at the right end of the Fraction given, as before, observe whether the number of the Fraction placed next above it may be divided into three even parts; if so, then take the third part thereof, and place another Chesseman at the right end of the Fraction next under that third part: but if that nnmber will not admit such an equall division, then neglecting the odde Fraction or Fractions so remaining, proceed with the numbers, which do so equally divide themselves, as before, and so you shall discover the third part you look for.*

Example. Let the 22 Fraction be given, and the third part of the distance required: Here, the numbet next above it is 21, whereof the third part is 7; where-

wherefore finding 7 amongſt the numbers placed at the right ends of the Fractions, I place another Cheſſman at the right end of the eighth Fraction, which denotes the third part required: Howbeit the 23 Fraction being given, an odde Fraction will remain over and above the number, which ſo equally divides it ſelf into three parts, as aforeſaid, and if the 24 Fraction were propounded, two ſuch odde Fractions would remain; which (neverthelesse) cauſeth no inconvenience in the practice of this Inſtrument, as ſhall be manifeſted in the proper place.

CHAP.

CHAP. IV.

The Application of the Rule of Proportion.

WE have done with Numeration, Application insues, which teacheth the use of this Instrument for the easie and ready resolution of divers Propositions in *Arithmetick* and *Geometry*, as followeth;

Prop. 1.

To three numbers given, to finde a fourth in a direct proportion.

This is termed the Rule of *Three* (or more usually) the *Golden Rule* because it is of greatest use in Arithmetick and Geometry: For the performance

formance thereof obſerve theſe enſuing directions.

I. *By the Inſtructions delivered in the ſecond Chapter aforegoing find the numbers given upon the Scale of Numbers, ſetting at each of them a pointed Cheſſeman, as alſo three other plain Cheſſemen upon the ſide rank of Alphabets at the left ends of their reſpective Fractions; This done, if by the fourth and fifth Rules of the laſt Chapter you will diſcover a fourth term to the three termes propounded, you ſhall there finde the number you look for.*

Example. If 12980 (repreſented upon the fift Fraction at the point *f*) be the firſt term given, 32191 (repreſented upon the nineteenth Fraction at the point *g*) the ſecond, and 18452 (repreſented upon the tenth Fraction at the point *h*) the third, the fourth term (by the fourth and fifth Rules of the laſt Chapter) will fall upon the four and twentieth Fraction at the the point *k*, (by the laſt Rule of the

the ſecond Chapter) gives you the number 45907, the fourth proportional required: ſo if 45907 vvere given for the firſt term, 18452 for the ſecond, and 32292 for the third (in working upwards upon the ſide-rank, and towards the left hand upon the table) the fourth term will be found to reſt upon the fift Fraction at the point *f*, repreſenting 12980, as before.

In like manner, if g *(viz. 32292)* were the firſt term given, *h* *(viz.* 18452) the ſecond, and *k* *(viz.* 45907) the third, the fourth term would fall upon the 15 Fraction at the point *l*, but (becauſe in that caſe you go beyond the table towards the right hand) you are to take inſtead thereof (according to the direction given in the third example of the fift Rule of the laſt Chapter) the point *m* upon the 16 Fraction, which repreſents 26231, the fourth proportionall required: ſo likewiſe if *h* (repreſenting 18452) be the firſt term, *g* (repreſenting 32292) the ſecond, and *f* (repreſenting 12980) the third, the fourth term will reſide upon the 14 Fraction

Fraction at four digits and four minimes of the 30 Interval, *viz.* at the point *n*. Howbeit, in this case also you are not take that point, but (because you overshot the Table upon the left hand) you are (instead thereof) to take the digits and minimes of the Fraction next above it in the same Interval, *viz.* the point *p*, upon the 13 Fraction, which represents 22715, the fourth proportionall required, according to the fourth example of the said fift Rule of the last Chapter.

Again, if *f* (*viz.* 12980) be the first term, *g* (*viz.* 32292) the second, and *k* (*viz.* 45707) the third. In this case the fourth term will (according to the fift example of the fift Rule of the last Chapter) at last reside upon the third Fraction at four digits and four minimes of the third Interval, *viz.* at the point *q*, which (by the fourth Rule of the second Chapter) represents 11422, the fourth proportionall sought for: On the other side, if *k* (*viz.* 45907) were the first term, *h* (*viz.* 18452) the second, and *f* (*viz.* 12980) the third,

the fourth term will (according to the laſt example of the ſaid fift Rule of the laſt Chapter) at laſt fall upon the 27 Fraction at four digits and four minimes of the 30 Interval, *viz.* at the point *r*, which repreſents theſe figures 52169: Howbeit, becauſe common ſence tells me, that the fourth term to the other three laſt given termes cannot be ſo great, nor yet ſo little as 521.69; therefore I conclude the term required to be (in this caſe) 5216.9, or 5217, *ferè.*

If a Cheſt of Sugar, that weighs 7 *C.* 2 *qu.* and 17 *lb.* coſt 36 *l.* 14 *s.* 10 *d.* what is the price of 2 *C*, 1 *q*, and 4 *lib.* thereof according to the ſame rate? Here (after the reduction of the broken parts of the number given into Decimals) the firſt term is 7.6518, the ſecond, 36.7417, and the third, 2.2857, with which three terms, working upon the Table, according to the precepts before premiſed, I find the fourth term to be fixed upon the ſecond Fraction at two digits and two minimes of the 17 Interval, which point yields me theſe figures

figures 10975, whereof I take the two first, (*viz.*10) for 10*l.* and the other three for a decimal Fraction of a pound Sterling, which (after Reduction) amounts to 19 *s.* 6 *d.* And therefore I conclude that 2 *C.* 1 *qu.* and 4 *lb.* of that Sugar is worth 10 *l.* 19 *s.* 6 *d.* which was the term required; for when I have those five figures given me upon the Table for the fourth term, common reason tells me, they cannot signifie 109.75, for that were too great, nor 1.0975, for that were too little, and therefore (in this case) I take 10.975, (*viz.* 10*l.* 19 *s.* 6 *d.*) being the fourth term sought for. Now from this *example*, and the rest before premised, for the ready working of the digits and minimes of the three termes propounded, this generall Rule, or Corollary may be inferred.

II. *In all questions that may be performed by the Golden Rule, the digits and minimes to be taken off from the first term are alwayes so taken off from that side of the first term which inclines towards the second term, and then the di-*

gits and minimes of the other two termes are alwayes taken off upon the contrary side to those of the first term; as is manifest by all the examples aforegoing, which Rule being alwayes duly observed, you may with greater confidence proceed to resolve any question propounded. And because this Corollary is alwayes to be kept in memory, I have expressed it in this *Distick*,

Aurata in Regula bis læva aut dextra petatur,
Dum contragreditur Terminus ipse prior.

Thus Englished:

For th' Rule of *Three* each hand may be pursued two times,
Whiles that the foremost term against them alwayes climes.

Prop. 2.

To three numbers given, to finde a fourth in an inversed proportion.

This Rule of Three *Inverse* is the same

ſame with that of the Rule of Three direct, if inſtead of the firſt term you take the third term given to be the firſt in the queſtion, by tranſpoſing the laſt into the place of the firſt.

Example. If when the price of wheat is 40 ſhillings the quarter, a peny white loaf weighs 8 ounces, and 9 peny-weight; how much ought a peny white loaf to weigh, when wheat is at 23 ſhillings, ſix pence the quarter? Here the termes given are, *viz.* 40 the firſt, 8.45 (after Reduction) the ſecond, and 23.5 the third, which, as they are propounded in the queſtion, ſtand in this form;

40 ———— 8.45 ———— 23.5

But being inverted, ſtand thus;

23.5 ———— 8.45 ———— 40

Unto which three, having (by the directions aforegoing) made ſearch (upon the Table) for a fourth proportionall, you ſhall find it to fall upon the ſixt

Fraction at three digits and three minimes of the 25 Interval, which point affords you these Figures 14.383, which (after Reduction) amount to 14 ounc. 7 peny-weight, 16 grains, being the term required; for so much a peny white loaf ought to weigh (according to the abovesaid rate) when wheat is sold for 23 *s.* 6 *d.* the quarter.

Prop. 3.

One number being given to be multiplied by another given number, to finde the product.

In multiplication there are four terms Geometrically proportionall, whereof the first is alwayes an unity, or 1, the multiplicator and multiplicand are the two meanes, and the product is the fourth term demanded; for, as 1 is to the multiplicand; so is the multiplicator, to the product: or, as 1 is to the multiplicator, so is the multiplicand, to the product. Now an unity or 1 being alwayes represented at the beginning

ning of the Scale of numbers (as appears by the eighth Rule of the ſecond Chapter) you need not there place a pointed Cheſſeman to denote it (being notorious of it ſelf) but onely where the multiplicand or multiplicator are found upon the ſaid Scale: when therefore any ſuch propoſition (as that above) is made, placing one pointed Cheſſeman upon the Multiplicator, and another upon the Multiplicand, as alſo two plain Cheſſemen upon the ſide rank at the right ends of their reſpective Fractious, and taking the beginning of the line to be alwayes the firſt term in the queſtion, by the directions given in the firſt propoſition of this Chapter, find out a fourth term to thoſe three terms propounded, which done, that fourth term is the product you look for.

Example. 287 being given to be multiplied by 139, the three termes given are,

1 ———— 139 ———— 287

Unto which, if a fourth be ſought for, by the inſtructions delivered in the firſt Propoſition of this Chapter, it will be found upon the 22 Fraction at four digits and three minimes of the 23 Interval, which point gives you theſe figures 39893, the product required.

What is a wedge of gold worth, that weigheth 4 ounces, 6 peny-weight, and 15 grains, at 3 *l.* 3 *s.* 2 *d.* the ounce? Here the weight of the wedge (after Reduction) is 4.3315, and the rate of an ounce is 3.1582; and therefore the termes given are,

1 ———— 4.3315 ———— 3.1582 ————

Whoſe fourth term I diſcover to fall upon the ſixt Fraction at two digits and one minime of the 33 Interval, which gives me theſe figures 1368, whereof I take the two firſt for pounds Sterling, and the other two for the decimal Fraction of a pound Sterling, which (af-

ter

ter Reduction) amounts to 13*s.* 7*d.* and somewhat more; for common reason dictates to me, that it cannot be 136 *l.* nor so little as 1 *l.* and therefore I conclude the product to be 13 *l.* 13 *s.* 7 *d.* as before, being the value of the 4 *ounc.* 6 *peny w.* and 15 *grains*, the term required. In Multiplication observe these Rules.

1 *In performiug Multiplication you alwayes operate upon the Table towards the right hand, and upon the side-rank of Alphabets alwayes downwards:* for an unity or 1 being alwayes the first term, you alwayes begin the account of the Alphabets and Letters comprehended betwixt 1, and the term placed next to it, from the left side of the Table, which will alwayes tend towards the right hand, and then (by consequence) in laying down the like distance betwixt the other term and the product, you are to proceed the same way, *viz.* towards the right hand; for the like reason it is, that you are alwayes to work downwards upon the side-rank, because there also you are to

begin your account from the first Fraction, being that, whereupon 1 (the first rerm) is represented: All which plainly appears by the premised examples.

2 *The digits and minimes which are to be taken off from the points of the termes given, are alwayes so to be taken off upon the left hand, and never upon the right.* Here, by the *termes given* are intended onely the *Multiplicand* and *Multiplicator*; for, the first term (*viz.* 1) hath no digits or minimes attending it, being represented upon the first perpendicular at the beginning of the Scale of Numbers; but the Multiplicand and Multiplicator may have digits and minimes attending them, which are alwayes to be taken off upon the left hand, according to the direction of this Rule, and as is manifest by the examples aforegoing.

Prop.

Prop. 4.

One number being given to be divided by another given number, to finde the Quotient.

As in Multiplication, so in Division there are four termes Geometrically proportionall; whereof the Divisor is alwayes the first, an unity or 1, and the Dividend the two mean terms, and the Quotient is the fourth term required: for, as the Divisor is to 1, so is the Dividend, to the Quotient; or as the Divisor, is to the Dividend; so is 1, to the Quotient: and here (as in multiplication) an unity or 1 being alwayes one of the terms you need not thereat place a pointed Chesseman to denote it; but onely where the Divisor and Dividend are found upon the Scale, as also two plain Chessemen upon the side rank at the right ends of their respective Fractions; and then taking the Divisor to be alwayes the first term in the question, by the directions given in the first Pro-

Propoſition of this Chapter, finde out a fourth term to thoſe three terms propounded; which done, that fourth term is the Quotient required.

Example. 39893 being given to be divided by 287, the three termes given are,

287 —— 1 —— 39893 ——

Or,

287 —— 39893 —— 1 ——

Unto which if a fourth term be found out by the inſtructions given in the ſaid firſt Propoſition of this Chapter, it will be found at the ſecond Hundred of the ſixt Fraction, which gives this number 139, for the quotient required: ſo likewiſe if 3989348 were given to be divided by 287, the firſt three figures of the quotient would be found 139, as before; but (in that caſe) you are to annex unto them two ciphers, to make the quotient conſiſt of five places; for that (in this queſtion) the diviſor may be writ-

ten

ten under the dividend five times, as appears by the posture of the numbers hereunto annexed.

3989348
287....

And therefore (in that case) the quotient required will be 13900; which case, with divers others (as they happen) the Artist (after he perfectly understands, by practice, the nature of this Instrument) will be well able (by discretion) to order, as occasion shall serve.

If a Pipe of wine (containing 126 Gallons) cost 25 *l.* 14 *s.* 5 *d.* what is the price of a Gallon thereof, according to the same rate? Here the terms in the question (after Reduction) are,

126 ——— 25.721 ——— 1 ———

For (in this case) the question is, if 126 Gallons give 25.721, how much will one Gallon yield? wherefore proceeding, according to the directions aforegoing, I finde the fourth term to reside upon the 12 Fraction at three digits and five minimes of the fift Interval,

terval, where I find these Figures represented, *viz.* 20377, which (in reason) I conceive to be a decimal Fraction of a pound Sterling, and (after reduction thereof) discover it to represent 4 *s.* 1 *d.* and so much is the value of every Gallon in the Pipe, and the Quotient required. In *Division*, for taking off the digits and minimes observe this Rule.

When the digits and minimes are taken off from the right hand of the Divisor, take the digits and minimes placed on the left hand of the Dividend; and when on the left hand of the Divisor, take them from the right hand of the Dividend. For the ready discovery and taking off the digits and minimes in *Multiplication* and *Division*, let this *Hexameter* be remembred.

Multiplicâ læve, sed divide dextrisinistre.

Multiply by th' right hand, with both the hands divide.

Prop.

Prop. 5.

Two numbers being given, to find a third Geometrically proportionall unto them, and to three a fourth, and to four a fift, &c.

This Propoſition may be reſolved by the directions given in the ſixt Rule of the laſt Chapter; for, having two termes given, and placing Cheſſemen upon them, as alſo at the right ends of their reſpective Fractions, as in the aforegoing Propoſitions, if you (by the ſaid ſixt Rule) find a third term to the two other given terms, that third is the term you look for.

Example. If 2 and 4 be the two terms given, a third proportional unto them (by the ſixt Rule of the laſt Chapter) will be found upon the 33 Fraction at two digits and two minimes of the 19 Interval, which point repreſents 8, the third term required: In like manner, you may proceed to find a fourth term to thoſe three, which will be 16, and a fift to thoſe 4 terms found, which wil be 32, &c. And ſo you may (by this means) erect

erect a rank of numbers Geometrically proportionall, which in *Arithmetick* is called *Geometricall Progression.*

Prop. 6.

To extract the Square root of any number under 10000000000.

FIrst, prepare the Square-number given for extraction (as in Vulgar Arithmetick) by subscribing a point under each other figure, beginning with the last first: so these numbers following being given for extraction, and prepared, as aforesaid, will stand thus,

328153225   1452753225

And so many points as are in that manner subscribed, of so many figures will the root consist, *viz.* in these examples of five figures.

2 *Place a pointed Chesseman at the number given, and likewise another upon the side-rank at the left end of the Fraction, whereupon the number given is sci-*

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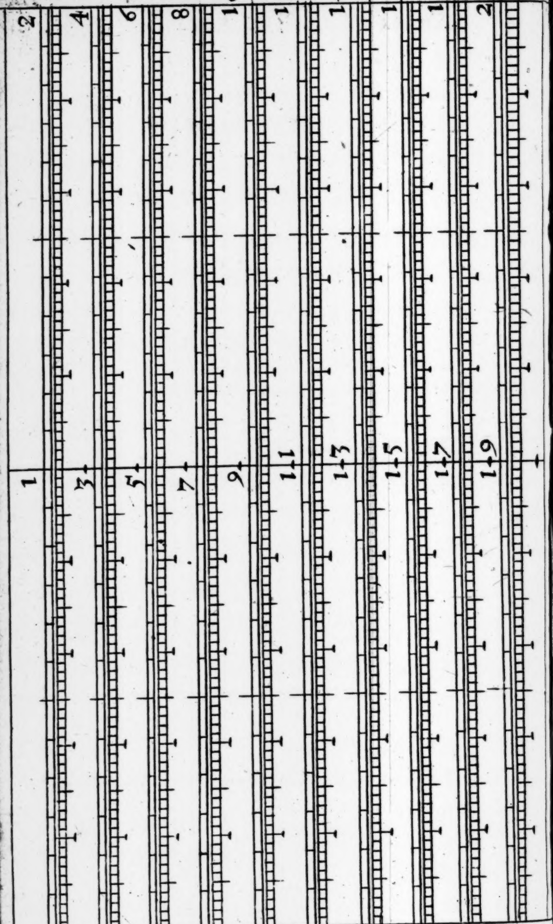

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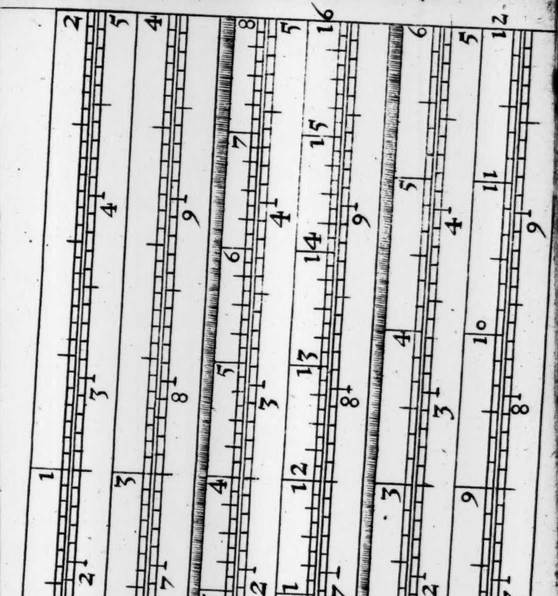

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tuate; this done, by the ſeventh Rule of the laſt Chapter, finde the half diſtance betwixt the point of the number given, and the left end of the Fraction whereon it is placed, as alſo (by the tenth Rule of the ſame Chapter) the half diſtance of that Fraction upon the ſide-rank: all this performed, if the firſt point towards the right hand happens to fall under the firſt figure of the number given, and there be no odde Fraction upon the ſide-rank, then the point, where the half diſtance of the Fraction of the number given meets with the Fraction of the half diſtance in the ſide-rank, will ſhew you the root required.

Example. Let 328153225 be the ſquare number given, & the root thereof required. This number admits five points to be ſubſcribed under it, (as appears before) and is found upon the 19 Fraction at five digits of the 21 Interval, alſo the half diſtance thereof (by the ſeventh Rule of the laſt Chapter) is likewiſe diſcovered at two digits and three minimes of the 11 Interval, as alſo the half diſtance in the ſide rank

rank (by the tenth Rule of the ſaid laſt Chapter) upon the tenth Fraction; wherefore if I place another pointed Cheſſeman upon the ſaid 10 Fraction at two digits and three minimes of the 11 Interval (being the ſame with the half diſtance upon the Fraction of the number given) that point will diſcover theſe figures 18115, being the root required.

3 *But when the firſt point towards the right hand happens to fall under the ſecond figure of the number given, and there be alſo an odde Fraction upon the ſide rank, proceed (as in the laſt Rule) to find the half diſtances upon the Fraction of the number given, and alſo upon the ſide rank: Howbeit, to diſcover the true Fraction, upon which the root (in ſuch caſe) is to be found, account three Alphabets downwards from the half diſtance upon the ſide-rank (in regard the firſt figure of the number given hath no point under it) & there place another plain Cheſſeman; Alſo (in regard of the odde Fraction upon the ſide rank) account in in like manner three Alphabets towards the*

the right hand from the half distance upon the Fraction where the number given is scituate, and there likewise place another pointed Chessman: All this performed, in the angle of position, where the last placed Chessman meets with the true Fraction of the root (before found upon the side rank) you shall discover the root required.

Example. Let the Square root of the number subscribed be desired.

145275 3225
• • • • • •

This number is found upon the sixt Fraction at one digit of the 31 Interval, and the half distance thereof at 3 minimes of the 16 Interval, as also the half distance in the side rank upon the 3 Fraction; but because I find no point under the first figure, I account upon the fide rank 3 Alphabets downwards from that 3 Fraction, and thereupon set another plain Chesseman at the left end of the 21 Fraction: Also, in regard (in this case) the fift Fraction in the side rank is an odde Fraction, I like-

likewise account three Alphabets towards the right hand from the half distance upon the Fraction, where the number given resides, and thereupon place another pointed Chesseman at three minimes of the 34 Interval; All this thus acted, I finde the Chesseman last placed to meet wtih the 21 Fraction (being the true Fraction of the root, as aforesaid) at three minimes of the said 34 Interval, where having placed another pointed Chesseman, I discover these figures 38115, being the root sought for. And here, let me give you this *Rule* once for all, That *whensoever there is no point under the first figure of the number given, you are to account upon the side rank three Alphabets downwards from the half distance there found, and when there is an odde Fraction upon the side rank, you are likewise to account three Alphabets upon the Fraction of the number given towards the right hand from the half distance found upon that Fraction*, as you finde it practised in the last *Example.* Note also, that when you have more figures discovered

upon

upon the Table for the root, then the number given requires, thoſe that exceed are a decimal Fraction belonging to the root; likewiſe when a mixt number is given, you are to ſubſcribe the points only under the ſignificant figures thereof:

And therefore if theſe two numbers, *viz.* 43623, and 1762.8 were given; the Square root of the firſt would be 208.86, and of the other 41.985. All which obſervations, and the like (after ſome practice upon the Table) common reaſon will dictate unto you.

Prop. 7.

To extract the Cube-root of any number given, under 1000000000000000.

1 *Prepare the Cube-number given to be extracted (as in Vulgar Arithmetick) by ſubſcribing a point under every third figure, and beginning with the laſt firſt:* So the number hereafter following prepared for extraction, will ſtand thus;

And

221989406612 5
. . . . . .

And ſo many points as are in this manner ſubſcribed, of ſo many figures will the root conſiſt, according to the aforeſaid obſervation of the Square-root.

2 *Place a pointed Cheſſeman at the number given, and likewiſe another upon the ſide rank at the left end of the Fraction upon which the number given is ſcituate; this done, by the eighth Rule of the laſt Chapter, finde the third part of the diſtance betwixt the point of the number given, and the left end of the Fraction whereon it is placed, as alſo upon the ſide rank (by the eleventh Rule of the ſame Chapter) the third part of the diſtance betwixt that Fraction and the firſt Fraction. All this performed, when the firſt figure of the number given towards the left hand hath a point placed under it, and you find no odde Fraction or Fractions upon the ſide rank, then the point where the third part of the diſtance of the Fraction of the number given meets with the Fraction of the third part of the diſtance in the ſide rank, will*

diſ-

discover unto you the Cube-root required.

Example. Let 2219894066125 be the Cube number to be extracted; this number admits five points to be subscribed under it (as appears above) and is found upon the 13 Fraction at five digits of the 17 Interval; also the third part of the distance, &c. (by the eighth Rule of the last Chapter) at three digits and four minimes of the sixt Interval, and likewise the third part of the distance in the side rank (by the 11 Rule of the last Chapter) upon the 5 Fraction; wherefore if I place another pointed Chesseman upon the said 5 Fraction at 3 digits and 4 minimes of the 6 Interval (being the same with the third part of the distance upon the Fraction of the number given) that point represents these figures 13045 .being the root you looke for.

3 *But when the first point towards the right hand happens to fall under the second or third figures of the number given, and there be also one or two odde Fractions upon the side rank, proceed (as in the last Rule) to find the third part of*

of the distance, &c. upon the Fraction of the number given, and also upon the side rank: Howbeit, to discover the true Fraction, upon which the root (in such case) is to be found, for every figure which the said first point hath towards the left hand (being never more then two) account two Alphabets downwards from the third part of the distance found upon the side rank, and there place another plain Chesseman; also for every odde Fraction, (which will never likewise exceed two) account in like manner two Alphabets towards the right hand from the third part of the distance upon the Fraction, where the number given is scituate, and there likewise place another pointed Chesseman: All this performed, in the angle of position, where the last placed Chesseman meets with the true Fraction of the root (before found upon the side rank) you shall discover the root required.

Example. Let the Cube-root of the number under-written be desired.

6419219206 4

The

This number is found upon the 30 fraction at two digits and five minimes of the third intervall, and the third part of the distance, &c. (by the eight Rule of the last chapter) at four digits four minimes and somewhat more of the first intervall, as also the third part of the distance in the side rank (by the 11 Rule of the last Chapter) upon the 10 Fraction; but because I find the first point of the number given to have a figure before it towards the left hand, I account two Alphabets downwards from the third part of the distance found upon the side rank (*viz.* From the 10 Fraction to the 22 Fraction) and there place another plain Chesseman, which 22 Fraction is the Fraction, whereupon the root is to be found, and therefore I place there another plain Chesseman: Again, for the two odde Fractions (*viz.* the 28, and 29) I account four Alphabets towards the right hand from the third part of the distance upon the Fraction of the number given, and there likewise place another pointed Chesseman: All this performed,

I finde the Cheſſeman laſt placed to meet with the 22 Fraction (being the true Fraction of the root, as aforeſaid) at four digits and four minimes and ſomwhat more of the 25 Interval, where having placed another pointed Cheſſeman, I diſcover theſe figures 4004, being the root required. So 172.68 being propounded to be extracted, the Cube-root thereof will be found upon the 27 Fraction at three digits of the 31 Interval, where you ſhall finde theſe figures repreſented 55686, whereof (common ſence tells me) 5 are the Integers, and the reſt of the figures are a decimal Fraction of the root, ſo as (in that example) the true root ſought for (after ſeparation of the Integral part from the broken part thereof) is 5.5686.

Here I might proceed to ſhew a further uſe of this *Inſtrument* for the reſolving of divers other Propoſitions in *Arithmetick* and *Geometry*; as, *Betwixt two numbers given, to diſcover one, two, or more mean proportionals*; *To three numbers given, to finde a fourth in a duplicated*

plicated or triplicated proportion; *To work Rules of plurall Proportion*; *The double Golden Rules direct and Inverse*; *The Rules of Fellowship, Alligation, False position, &c.* But I have deemed these (at present) sufficient to satisfie the curiosity of the *Practitioner*, who in obtaining the knowledge of these, (if he esteem them worthy his paines) may be thereby so perfectly acquainted with the nature of the *Table*, that he may afterwards be able to resolve not only the Propositions above-mentioned but all others, which may be performed by *Arithmetick* either Vulgar or Artificial; And (perhaps upon further scrutiny) some others also, which cannot be resolved without *Symbolicall Arithmetick*, usually called *Algebra*: All which I will hereafter eudeavour also to explain, (as vacancie frō other more pertinent affairs will permit) together with the Fabrick and Use of a *Trigonometricall* Table of Proportion for the resolution of Plain and Sphericall Triangles, if I shall finde the paines herein already taken may obtain grate-

full reception: This Tractate being (indeed) onely intended as an *Eschantillon*, or glimpse of that which may be performed upon this and the other above-said Table applicable to *Trigonometry*. *Præstat pauca avide discere, quàm multa cum tædio devorare.* Erasm. *in Coll. rel.*

FINIS.

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